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The Editor's Page

THE Boston office of the Institute is now located in more convenient quarters at the old address, 65 Franklin St., and the telephone number has been changed to Hubbard 9630.

* * *

CO-OPERATORS in the Institute's warp sizing study are to meet at the Hotel Pennsylvania, Friday, Sept. 9, to receive and discuss reports of Director Yelland and members of the Administration Committee, and to consider a program for future work. Progress Report No. 16, which was recently delivered to co-operators and which contains results having unusually valuable practical application, will be supplemented by an additional report confirming original findings.

* * *

DR. WILLIAM E. YELLAND, who has been associated with the Institute's warp sizing research since its start in 1935, and has been its director since Jan. 1, 1936, has tendered his resignation, becoming effective at the end of this month, to become associated with the research laboratory of Corn Products Refining Co. Under Dr. Yelland's direction many valuable innovations and new techniques in the sizing of rayons with gelatins and glues have been developed. He deserves and will have the heartiest wishes for success in his new activities of all who have been associated with him in the warp sizing research.

* * *

WE believe that it will astonish many of the Institute friends of Philip A. Johnson, of the Board of Directors and Executive Committee, to learn that he is a mountain climber extraordinary. With his friend Dr. James Bryant Conant, president of Harvard University, he scaled last July North Twin Mountain, third highest peak (12,085 ft.) in the Canadian Rockies. It was the fourth successful ascent of this peak, the last having been made in 1927. Probably you saw one of the many news reports and pictures crediting Dr. Conant and party with having performed the feat. Mr. Johnson was the modest "party."

* * *

WILLIAM W. BUFFUM, treasurer and general manager of The Chemical Foundation, has resigned the office of treasurer of the National Farm Chemurgic Council. He was one of the founders and a member of the original Board of Governors of the latter organization. It is understood that his resignation was necessitated by his increased activities as president of the Atchison Agrol Company, the first power alcohol plant in the country. Anhydrous ethyl alcohol is manufactured from mid-western farm crops, and it is reported that distribution of the alcohol and gasolene

blended fuels now covers nine mid-western states under the trade name "Agrol."

* * *

RESEARCH directors from various industries engaged in round table discussion dealing with administration, organization and personal problems of their laboratories at the recent meeting in Atlantic City of the recently-organized Industrial Research Institute. Robert B. Colgate, vice-president in charge of research for the Colgate-Palmolive-Peet Co., Jersey City, N. J., who is chairman of the Institute's executive committee, presided. Representatives of textile companies attending the meeting were L. Dearstyne, Collins & Aikman Corp., Philadelphia, Pa., and G. E. Hopkins, Bigelow-Sanford Carpet Co., Thompsonville, Conn. A project contemplated by the Institute would involve co-operation with domestic colleges and universities in the training of men for scientific and industrial research.

* * *

THE spun rayon group of Committee D–13 of the A. S. T. M. is to conduct a symposium on spun rayon and blended fibres in connection with the fall meeting of the Committee in New York City, Oct. 19–21. Speakers and subjects already arranged for are as follows: "Rayon Staple Manufacture," Dr. F. Bonnet; "Fabric Merchandising and Construction of Spun Rayon and Blended Fabrics," Alexis Sommaripa; "Finishing of Spun Rayon and Spun Rayon Mixtures," William H. Cady; "Test Methods," Dr. H. DeW. Smith. In addition to the symposium, the sub-committee on spun rayon, known as Section III of Sub-Committee A–2, expects to draw up tentative methods of testing and tolerances for rayon staple. Ashton M. Tenney, president, A. M. Tenney Associates, is chairman of sub-committee A–2 on rayon, and Kenneth B. Cook of Manville-Jenckes Corp., heads Section III on spun rayon.

* * *

Declaration of Scientific Faith

"I am the inheritor of the tradition of civilization which has proved more lasting than empires. Whenever I use the language or the products of science I unconsciously pay homage to the countless men for whom no sacrifice was too great in the struggle to develop the human mind and establish the truth. Toleration and freedom are the heart of this tradition; for individual thought and love of truth are the basis not only of science, but also of justice and of civilization.

"I declare my loyalty to this tradition, my belief in the freedom of the individual to develop his talents for the enrichment of the community, and my conviction that man's community is now the whole human race, within which each nation must play its characteristic part. The natural balance between personal freedom and the proper demands of society, which is the life and health of civilization, is today doubly threatened: in certain societies by the denial of freedom and in the democratic countries by the irresponsibility of individuals. In the face of this threat:

"I pledge myself to use every opportunity for action to uphold the great tradition of civilization, to protect all those who may suffer for its sake, and to pass it on to the coming generations. I recognize no loyalty greater than that to the task of preserving truth, toleration, and justice in the coming world order." L. L. Whyte, *Nature*, May 7, 1938.

Obituaries

Harry W. Butterworth, Sr.

Harry W. Butterworth, Sr., president until 1929 and later chairman of the board of directors of H. W. Butterworth and Sons Company, Philadelphia, textile finishing machinery, died August 3 at his home in Rydal, Pa., in his 75th year. Mr. Butterworth is credited with being the father of the textile finishing industry in the South, the latter dating from the time he sold the first warp dyeing machine in Alamance County, N. C. He is survived by his second wife and five children: Harry W. Butterworth, Jr., James Butterworth, 2nd, De Haven Butterworth, Mrs. L. C. Dick and Mrs. John H. S. Spencer.

* * *

John E. Edgerton

John E. Edgerton, president and general manager of the Lebanon (Tenn.) Woolen Mills and a former director of the Institute, died at his home in Lebanon, August 4, in his 58th year. Born on a small tobacco farm in Johnson County, N. C., his education was financed by an elder brother and he was graduated from Vanderbilt University in 1902. He rose to national industrial, religious and educational leadership, was a founder of the Columbia, Tenn., Military Academy, national chairman of The United Prohibition Forces to Preserve the Eighteenth Amendment, president of the National Association of Manufacturers from 1921 to 1931, when he resigned and became chairman of the board, and was the founder of the Southern States Industrial Council. He is survived by his widow, a daughter and a sister. He has been succeeded as president and general manager of the Lebanon Woolen Mills by his nephew, Howard Edgerton.

"OBSOLETE MACHINERY of however great beauty, or the newest machinery for making a fabric nobody wants, are unpleasant to our thoughts; but if by research we do not keep ahead of the times we shall have both. The New England specialist in horse blankets about 20 years ago probably did not begin research on motor robes when the Selden automobile patents were first issued, but when there was no longer any market for horse blankets."
—Prof. E. B. Millard.

Geometric Fineness of Cotton Fibres and Associated Cross-Sectional Features: Their Comparison by Means of Graduated Scales*

By ENOCH KARRER and T. L. W. BAILEY, JR.†

Introduction

FINENESS of fibre appears to be one of the more important physical properties upon which spinning value depends.[1, 2, 4] It is however, a fibre property which is not easily, readily and accurately evaluated in commercial practice at the present time, although most cotton classers can distinguish between relatively wide ranges of fineness.

Quality specifications for products manufactured from raw cotton, especially those to serve mechanical and other special purposes, are continually being revised and made more rigid and exacting. Spinners and other manufacturers, however, are finding themselves more and more in the predicament that frequently they cannot meet specifications due to their inability properly to recognize and secure in sufficient quantities raw cotton with the combination of fibre properties and characteristics necessary to meet the quality requirements of their manufactured products.

In addition, seasonal fluctuations occur in cotton quality, as they do for most all agricultural commodies. Two recent examples of this have occurred with American cotton; crops of 1937 and 1931. Tire cord manufacturers more especially have reported some uncommon problems and experiences with their selections out of these crop years.

As a consequence, spinners, manufacturers and shippers are becoming more and more interested in the quality of raw cotton and in more accurate, rapid, and practicable methods, even scientific ones, for measuring various fibre properties which are not readily susceptible to evaluation by commercial classification.

Fibre fineness is correlated to a considerable degree with staple length and for this reason spinning results, really dependent upon fineness, have often been ascribed to length of fibre; this has resulted in confusion for buyers and spinners. In the absence of any practical commercial method and standards for evaluating fineness much attention is being given in technical and research laboratories to scientific methods and devices. The

* These studies are a part of the program of work in the fibre technological laboratories of the Cotton Utility and Standards Research Section, under the general direction of Robert W. Webb, Principal Cotton Technologist. This paper was presented in part before a meeting of Subcommittee A–1, Section 1 on raw cotton, Committee D–13 (Textiles), ASTM, at Washington, D. C., on March 10, 1938.

† Senior and Associate Cotton Technologists, respectively, Bureau of Agricultural Economics, U. S. Department of Agriculture, Washington, D. C.

method described by Bailey and Conrad [2] for weight per inch, while lacking little in the way of precision, is entirely too laborious for more general or widespread commercial application. Thus, spinners and manufacturers of special products are eagerly awaiting some more rapid and practicable procedure that they may adapt to their special needs.

Cotton breeders, too, are seriously handicapped by lack of any sufficiently rapid method which they can use in making their selections and rejections on a basis of fibre fineness in their effort to get high quality individuals from a vast and almost countless number of progenies. Obviously, the nature and extent of the progress which they can make in this direction depends, in considerable part, on having more precise and rapid methods.

Fineness is most commonly measured in laboratories in terms of fibre weight per unit of length, rather than in terms of diameter or cross-sectional area. One may, therefore, refer to the former as "gravimetric" or "weight" fibre fineness in contrast to "geometric" or "dimensional" fineness. The more general use of weight fineness has resulted, no doubt, from convenience of technic rather than from any special design. However, such data are useful.

Nevertheless, expression of fibre fineness in terms of weight has certain disadvantages. It is rather abstract, and does not give any indication either of the shape of the cross-section or the area of lumen. Expression of fineness in terms of fibre cross-sectional characteristics may be more important than gravimetric fibre fineness in so far as mechanical properties, such as pliability, and coefficients of torsion and friction are concerned. Undoubtedly, these enter into and influence not only the fabrication of yarns and fabrics but also their physical and mechanical properties, or their wearing and service performance.

The possibility of developing a more rapid and practicable method for measuring cotton fibre fineness, based on geometrical characteristics, has been under study for some time in the Bureau's laboratories. The approach to the problem has been made on the assumption that a technic might be worked out whereby cross-sections of representative fibres from any sample, whose fineness characteristics were desired, could be relatively quickly prepared and compared on a scale of previously selected photomicrographs of cross-sections representing a practical range of both size and shape of cross-section.

In this connection, it has been felt that if such a technic for sectioning and making comparisons could be developed into a routine, the development would be useful, on the one hand, to spinners and manufacturers of special products who have to meet rigid and exacting specifications, and, on the other, to cotton breeders who at present must rely on vague impressions of fibre fineness for their guidance in accepting or discarding their progenies. This report describes the progress thus far made on this problem.

Materials and Methods

The samples used in these studies were selected from a large number and wide range of cottons, including American Upland, Sea Island and Asiatic types; numerous varieties, selections and crosses, and known growth histories in most cases. In the development of the background to and basis of the discussion here reported, a total of more than 100 samples and

10,000 fibres has been considered. These, in turn, have involved a total of approximately 60,000 measurements with planimeter and bi-diameter scale and about 70,000 calculations plus duplicate checking. Some 14 of the samples were from the Regional Variety Studies being conducted throughout the cotton belt by the Bureau of Plant Industry.

The use of the cross-sectioning device recently described by Hardy [5] has given a point of departure in the study of cotton fibres, both in regard to method and to tools, from the old or more general type of embedding and microtome sectioning. Essentially the same technic as Hardy described for wool sectioning has been employed in these studies. The principal difference is that the cotton fibres are not subjected to any cleaning or other processing that might affect the size or shape of cross-section.

Briefly, the so-called Hardy device consists of a thin metal plate, slotted to receive the fibres, and is about the size of a microscope slide; upon the plate is a mounted and removable thumb screw which directs a plunger into the slot to force the fibres beyond the surface of the reverse side where they may be sliced off with a safety razor blade. Using, for the most part, the sampling procedure as employed in tests for length, fineness and maturity,[2] a small tuft of several thousand cotton fibres is combed and paralleled, inserted in the slot of the metal plate and wetted with a drop of collodion containing oil black BG dye to improve the contrast. After the collodion has dried the two projecting ends of the tuft are cut off with a sharp safety razor blade flush with the surface of the plate. The plunger and thumb screw are put in place. The fibres are pushed out about 10 to 15 microns beyond the surface of the metal plate. A thin coating of transparent collodion is then brushed on, and, after this dries, the projecting portion is sliced off flush with the metal, yielding a section 10 to 15 microns thick, embedded in the hardened collodion film. For temporary and immediate observation or photomicrographing the section is transferred onto a microscope slide, touched with a drop of glycerine and protected with a glass cover slip. Sections of the fibres desired for future observation were mounted in Canada balsam.

Photomicrographs were taken with an H-type camera equipped with a 20X apochromatic objective and 12.5X hyperplane ocular, using a slow dry plate. Enlargements on bromide paper four times the photomicrographic negative presented the fibre cross-sections at a magnification of 1000 times for all measurements reported here.

On the enlargement, the area of 100 cross-sections of fibres and lumens chosen at random were measured with a compensating polar planimeter. The major and minor axes of fibre and lumen of the same 100 cross sections were measured by means of a bi-diameter scale.[6] The mean value of total area, lumen area, net area, major and minor axis, wall thickness and their coefficient of variation were computed for each sample.

Range of Magnitude of Cross-Sectional Features

The first striking characteristic observed in the cross-sections of cotton fibres is the variability in practically every dimensional feature which one may mention, such as over-all diameter, lumen diameter, ratio of maximum and minimum dimensions, shape of contour, total area and area of cellulose. Cottons thus far observed in cross-section by the use of this technic show a variation in the over-all area of fairly round fibres

from 26 to 984 square microns (3,800%). The range in wall thickness of cottons observed and measured in cross-section varies from about 0.35 microns to 15.5 (4,400%). Lumen width (minor axis) varies from 0.35 of a micron to 12 (3,400%), while the major axis of the lumen 0.50 to as much as 40 (8,000%).

The cotton fibres thus far studied present practically the entire or full range of shapes; that is, from almost round to the nearly linear. This occurs independently of the size, independently of the cross-sectional area, and independently of the amount of cellulose in the fibre, and independently of the wall thickness of the fibre.

In a general way, cotton fibres may be identified or classified with respect to cross-sectional shape into three categories: (1) "circular," with a range in ratio of maximum to minimum diameter of 1 to 1.80, inclusive; (2) "elliptical," in which the range of ratios is 1.81 to 4.00, inclusive; and (3) "linear," in which the ratio is 4.01 or more. The greatest ratio of maximum to minimum axis thus far observed in cotton is approximately 12 to 1 (1,200%). Fibres of each of the three shape categories, as described, have been found in all of the types and growths of cottons thus far studied. Presumably, they all exist in varying degree in all naturally grown cottons.

The specimens of cross-sections magnified about 700 times, as shown in Plate I and as described by the dimensional data in Table 1, have been

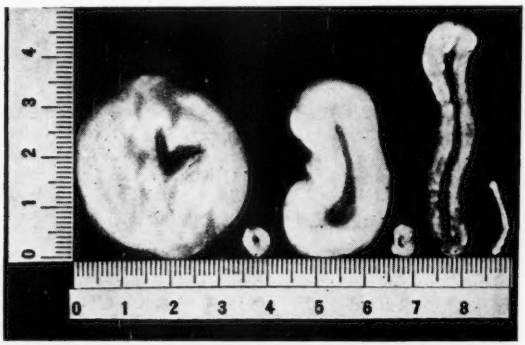

PLATE I. Extreme sizes and shapes of cotton fibre cross-sections. Approximately 700 ×.

selected to show the extremes of size that may be found in each of the three mentioned categories of shape. Of the circular fibres (Plate I, left pair) the larger was found in an Asiatic cotton, the smaller, in a Sea Island; the larger and smaller elliptical cross sections (Plate I, center pair) also were found in the same cottons, respectively. The larger of the fibres of linear cross section (Plate I, right pair) was from an American Upland, the smaller from a Sea Island cotton. It is not likely that such great range of size would be encountered in any one sample of cotton. However, this illustration shows that the description in terms

TABLE 1

Extreme Sizes and Shapes of Fibre Cross-sections

Fibre type	Area, μ^2			Diameters, μ					Wall thickness μ
				Lumen		Fiber			
	Total	Lumen	Net	Major	Minor	Major	Minor	Major Minor	
Large circular from 5/8" Asiatic	984	40	944	14.0	3.0	37.0	34.0	1.09	15.5
Small circular 1-3/4" Sea Island	26	4	22	1.50	1.0	6.0	5.0	1.20	2.00
Large elliptical American upland 7/8"	616	32	584	21.5	2.0	36.0	17.0	2.11	7.5
Small elliptical American upland 7/8"	40	4	36	2.0	0.6	6.5	3.50	1.86	1.45
Large linear American upland 7/8"	392	64	328	37.0	2.0	47.0	8.0	5.86	3.00
Small linear American upland 1-3/4"	56	4	52	13.0	0.50	15.0	1.25	12.0	0.35

of the three categories of shape is applicable to all cottons whether coarse or fine.

The great variability in cotton fibres with respect to lumen size and wall thickness is illustrated in Plate II, and more particularly described in Table 2 by the three pairs of cross-sections, magnified about 700X. The

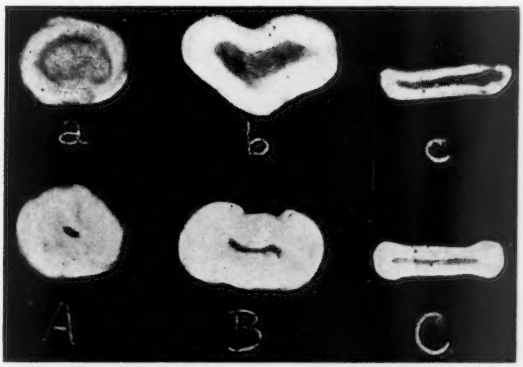

PLATE II. Extreme lumen areas in cotton fibre cross-sections of different shapes (The total areas of the paired specimens are approximately the same.) Approximately 700 ×.

thicknesses of the walls of circular fibres a, A, which have approximately equal areas, are 3.0 and 8.5 microns, respectively; of elliptical fibres b, B, with equal areas 6.00 and 7.75 respectively; and of fibres linear c, C, with equal areas 1.50 and 2.25 respectively.

TABLE 2

Extreme Lumen Areas in Cotton Fibre Cross-sections of Different Shapes but Equal Total Areas

Fiber type	Area μ^2			Diameters μ					Wall thickness μ
				Lumen		Fibre			
	Total	Lumen	Net	Major	Minor	Major	Minor	Major / Minor	
(A) Circular, small lumen	312	9	304	3.0	1.0	22.0	16.0	1.22	8.5
(a) Circular, large lumen	312	84	228	14.0	9.0	21.0	15.0	1.40	3.0
(B) Elliptical, small lumen	396	16	380	11.0	1.0	29.0	15.5	1.87	7.75
(b) Elliptical, large lumen	380	80	300	21.0	5.0	30.0	17.0	1.81	6.00
(C) Linear, small lumen	156	12	144	17.5	1.0	26.5	5.5	4.82	2.25
(c) Linear, large lumen	156	32	124	22.0	2.0	26.0	5.0	5.20	1.50

Average Cross-Sectional Features of Different Cottons

The above tables and photomicrographs give the cross-sectional features of cotton fibres which were selected to emphasize the wide range in these cross-sectional features. Every sample of natural grown or raw cotton contains individual fibres manifesting extreme cross-sectional features. The sample, however, itself is perhaps best characterized not by extremes in these cross-sectional features, but by the average of them with due regard to their variability. Different cottons also present rather large variations in such average values of these cross-sectional properties.

A sample of cotton taken at random contains fibres of many different lengths. However, even though the fibres be taken from the same length group of the sample, there is great variation, as illustrated in Plate III, where cross-sections (magnified about 375X) of fibres are taken from a sample of American upland cotton, classed as 1–1/8 inch staple length, as follows: A, the 7/16th inch group of the length array; B, the 19/16th inch length group. For the cross-sections of the fibres 7/16th inch long out of this particular sample the coefficient of variation of total area is 53.07%; and for those of the fibres 19/16th inch long, 22.95%.

Samples C and D, Plate III, exhibit for two different samples of cotton another type of variability observed in fibre cross-sectional characteristics. The average areas of the lumens in these two samples differ quite markedly. Sample C has an average lumen area of 22.8 square microns whereas sample D has an average lumen area of 37.9 square microns, or 66% larger than that of sample C. The average total area for samples C and D are exactly the same; i.e., 210.6 square microns.

The nature and extent to which different cottons vary in the average cross-sectional dimensions characterizing them is shown in Plate IV. These form a series of steps or intervals based largely on weight per inch, as shown in Table 3. A wide range of average total cross-sectional

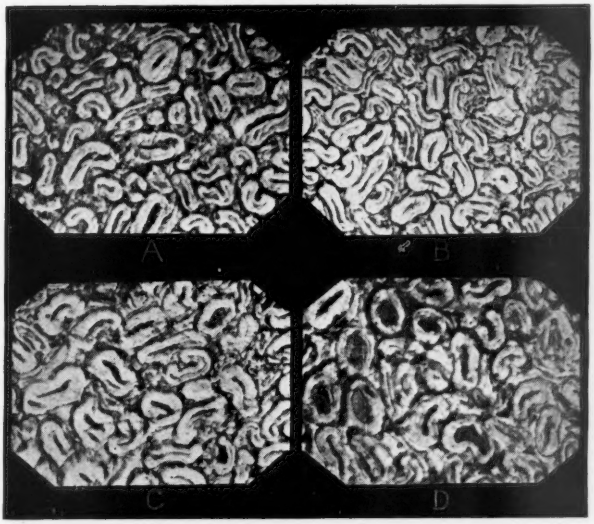

PLATE III. Variability of total area and average lumen area. (A) and (B) from the 7/16th and 19/16th inch length group of the same cotton respectively had coefficients of variability of total area of 53.07% (A) and 22.95% (B); (C) and (D) from two different cottons had average lumen areas of 22.8 and 37.9 square microns, respectively, but equal total areas. Approximately 375 ×.

TABLE 3

Dimensional Characteristics of Fibre Cross-sections of Cottons Having Different Average Fibre Weight Per Inch

Sample* No.	Weight, μg./in.	Average areas μ^2				Coef. var. total area	Average diameters, μ					Ave. wall thick. μ
		Total	Lumen	Net	Net/Total		Lumen Major	Lumen Minor	Fibre Major (M)	Fibre Minor	Major/Minor	
A	1.30	71.64	11.56	60.1	1.19	45.9	10.8	1.05	16.7	4.32	3.81	1.63
B	2.37	96.7	13.5	83.2	1.16	29.7	10.3	1.35	16.9	5.88	2.09	2.26
C	3.45	120.9	11.5	109.4	1.10	30.1	9.4	1.38	17.4	7.50	2.31	3.06
D	4.30	145.1	16.8	128.3	1.13	27.1	9.58	1.81	18.6	8.03	2.42	3.11
E	5.50	159.8	19.9	140.0	1.12	28.8	9.79	2.05	19.0	9.31	2.04	3.63
F	7.70	188.0	19.8	168.4	1.12	24.2	12.4	1.60	21.2	8.60	2.46	3.50
G	9.70	262.3	25.6	236.7	1.10	25.0	11.2	2.11	23.1	12.2	1.89	5.05
H	12.70	396.1	18.96	377.2	1.05	31.6	8.45	1.88	26.5	16.9	1.56	7.51

* These cottons are arranged in order of weight fineness (micrograms per inch); this also arrays them in order of increasing total cross-sectional area. The values in the table are averages for the whole sample.

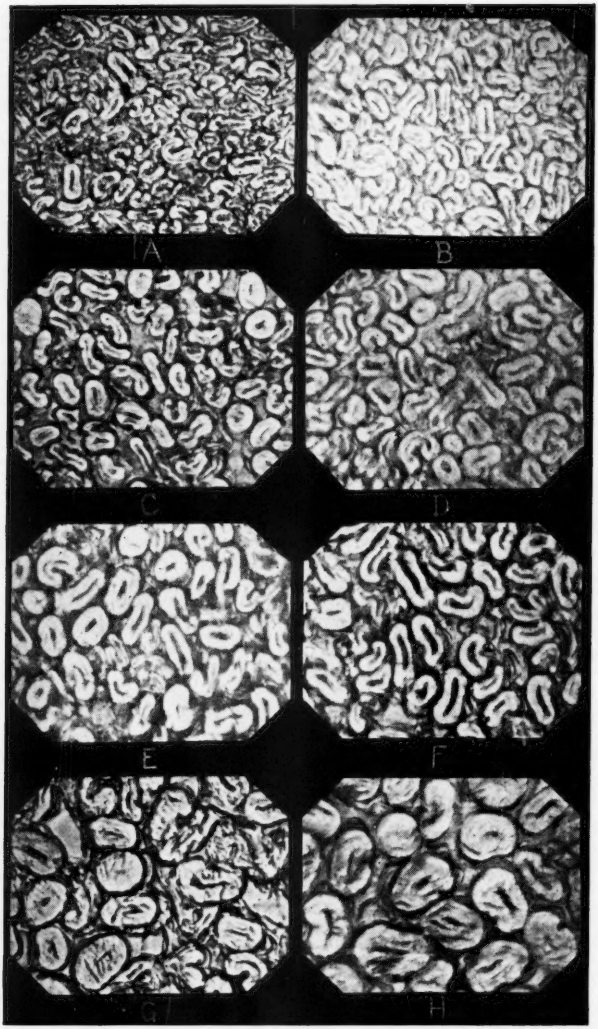

PLATE IV. Cross-sections of fibres from a series of cottons of increasing weight per inch. Approximately 375 ×.

areas is included, extending from a weight per inch of 1.30 micrograms and 71.6 square microns (A, Plate IV), for a very fine cotton to 12.7 micrograms and 396.1 square microns (H, Plate IV), for a very coarse cotton. Based on the lower values weight per inch varied 980% and the area 550%. The average ratio of major to minor axis of the fibre cross-section varied from 3.81 for the fine sample to 1.56 for the coarse sample, a range of 240%; and the average wall thickness varied from 1.63 microns for the fine to 7.51 microns for the coarse samples, a variation of 460%. The lumen areas remained more constant, varying from 11.5 to 25.6 square microns a variation of only 220%.

Practical Comparison or Evaluation of Fibre Cross-Sections

Since any given sample of cotton may contain fibres with cross-sections of each of the three shape categories, and of areas widely variant irrespective of shape, it becomes necessary, in order to facilitate comparison and evaluation of unknown cottons on a basis of cross-sectional area and shape, to set up a scale of gradations of these features. The first step in this direction has been to prepare panels of cross-sections in intervals of equal area, designated by Roman numerals as indicated in Table 4. Each panel contains cross-sections of each of the three cate-

TABLE 4

Ranges of cross-sectional areas and diametral ratios of the theoretical comparison panels

Panel No.	Range of cross-sectional areas, μ^2	Range of diametral ratios		
		A, circular	B, elliptical	C, linear
I	0–79	1–1.80	1.81–4.00	4.01 and greater
II	80–119	do.	do.	do.
III	120–159	do.	do.	do.
IV	160–199	do.	do.	do.
V	200–239	do.	do.	do.
VI	240–279	do.	do.	do.
VII	280–319	do.	do.	do.
VIII	320–359	do.	do.	do.
IX	360–399	do.	do.	do.
X	400–439	do.	do.	do.
XI	440–479	do.	do.	do.
XII	480 and greater	do.	do.	do.

gories of shape previously mentioned; namely, A, circular, with diametral ratio of 1 to 1.80; B, elliptical, with diametral ratio of 1.81 to 4.00; and C, linear, with diametral ratio of 4.01 and greater.

The steps in area, from panel to panel, go by intervals of 40 square microns except at the extreme positions. Each panel provides for three groups of cross-sections: circular, elliptical and linear. In the panel for the smallest cross-sections, the areas all lie in the range of 79 or less square

microns per fibre; in the next, from 80 to 119 square microns per fibre, and so on to the panel of greatest cross-sections which contains groups of each of the three shape types having areas of 480 or more square microns per fibre. These 12 panels are being constructed by cutting out from the enlargements the cross-sections that had been measured, and arraying on cardboard after sorting as to area group and shape type.

The photomicrograph of a cross-section of any unknown cotton may be moved up and down the series of panels having cross-sections of the same shapes but of different area, and across the panels of equal area of cross-section but of different shape until the cross-section of the unknown is most nearly matched in area and shape by the cross-sections of a comparison panel.

In Plate V (A, B and C) show one of the comparison panels of fibre cross-sections; namely, Panel III. D, E and F represent cross-sections of same magnification of three different cottons which are to be compared with the parts of the comparison Panel III. Fibres in sample D are definitely smaller in total cross-sectional areas than those on Panel III, and, therefore, must be compared with some other panel of smaller cross-sectional area. Likewise, those of sample F are on the average definitely larger in average total cross-sectional area per fibre than those on the panel, and must be compared with a panel of larger cross-sectional areas. However, the fibres of sample E appear about equal to those on the comparison panel shown, and for shape category can be matched further most exactly with the elliptical group, B, of the panel. Table 5 contains the data for the samples and comparison Panel III, shown in Plate V.

TABLE 5

Average total area, length of axes, ratio of axes and wall thicknesses of the theoretical and actual comparison panel, and of three different samples of cotton

Sample	Average total area, μ^2	Diameters μ		Major / Minor
		Major	Minor	
Panel III, B, theoretical	120–159	—	—	1.81–4.00
Panel III, B, actual	136.4	19.0	7.1	2.68
Sample D	96.7	16.9	5.88	3.02
Sample E	148.0	18.9	7.90	2.40
Sample F	178.6	20.6	9.50	2.17

The assortment of cross-sections, representing the various gradations of cross-sectional area for each of the three shape categories, was obtained from about 100 different cottons selected to cover the widest known range, after measurement of 100 fibre cross-sections on photomicrographs. Cross-sections of extreme areas do not occur very frequently. The frequency distribution of the cross-sections of the different areas that occurred in the 7,000 measured is shown in Fig. 1.

Much of the time and expense involved in photographing and enlarging can be eliminated by projecting on a screen or wall cross-sections of the unknown cotton fibre along side of those in the comparison panels. In making all such comparisons, obviously the same magnifications must be used for the unknown as that of the panel. This procedure thus makes

possible a more rapid comparing and evaluating of cotton samples on a basis of fibre geometric fineness and associated cross-sectional features than otherwise would be the case. The method, however, is still not sufficiently rapid and practicable for commercial or general use, in the marketing or buying and selling of cotton. Nevertheless, the method does have great value for the information which it will give, when applied to the practical problems of cotton breeding, of explaining differences in cotton spinning quality, and of calibrating mill types against which cotton is to be selected or rejected.

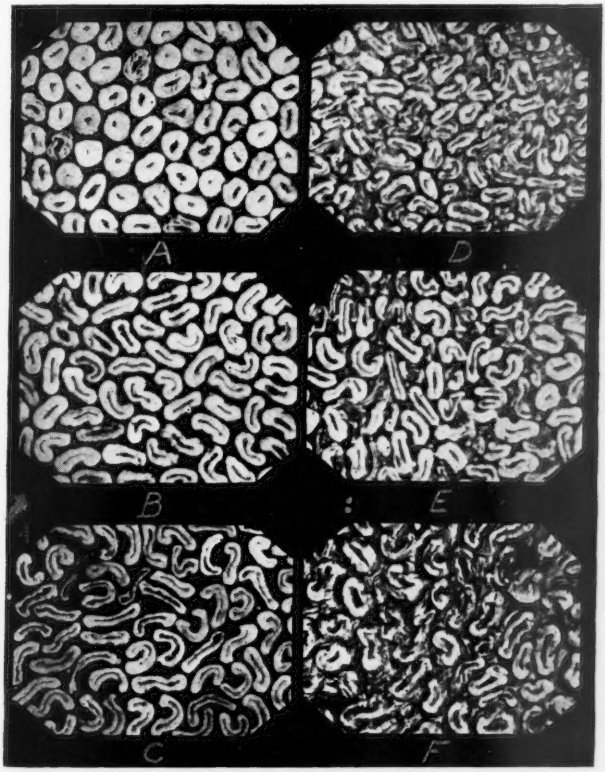

PLATE V. Comparison Panel III of cross-sections with areas 120 to 159 μ^2 composed of (A) circular, diametral ratio 1 to 1.80; (B) elliptical, ratio 1.81 to 4.00; (C) linear, ratio 4.01 and more. Three cottons of cross-sectional area: (D) smaller than that in Panel III, (F) larger than that in Panel III, (E) approximately equals area in Panel III and more nearly matches (B) in shape. Approximately 375 ×.

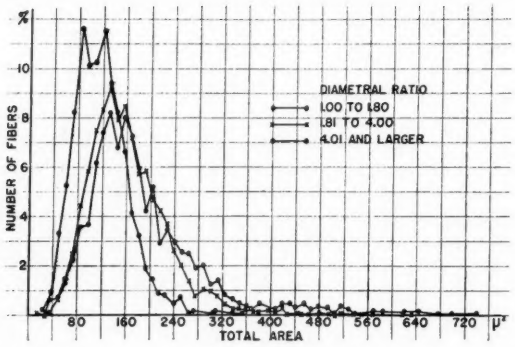

FIG. 1. Distribution of total area of cross-section of fibres of each of the three diametral ratios, as used in the preparation of comparison panels.

Cross-Sectional Features of Cotton Fibres as Related to Other Properties

One might expect some interrelationships between the cross-sectional properties of fibres and certain other properties such as weight per inch, wall thickness, lumen area, fibre strength and fibre length. Some data have been assembled to show the trends in a few of these relationships. In Fig. 2, the weight per unit length (micrograms per inch) is plotted

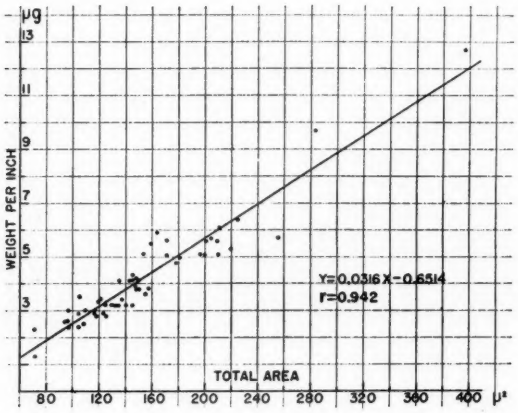

FIG. 2. Relation of average weight per inch of cotton fibres to average total area of cross-section.

against average total area in cross-sections of the fibre. This is a linear relationship in which the weight per unit length (Y) increases with the total area (X), in accordance with the following equation, which holds for areas from 60 to 400 square microns:

$$Y = 0.0316X - 0.651$$

In Fig. 3 we see a tendency of the net cellulose area (Y) to vary directly with the over-all area (X) of the cotton fibre. This linear rela-

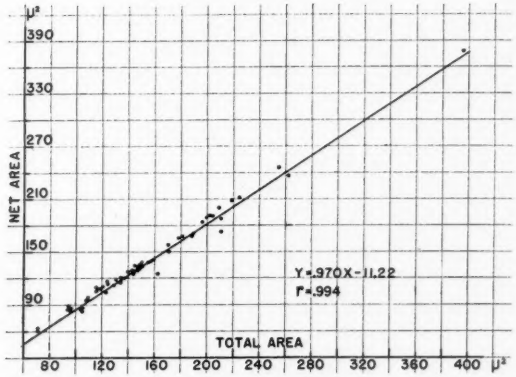

FIG. 3. Relation of net area of fibre cross-section to average total area.

tionship is expressed by the following equation, holding over a range of total area from 60 to 400 square microns:

$$Y = 0.970X - 11.22$$

In Fig. 4 are given a few measurements from which the relationship between net area (Y) and wall thickness (X) is indicated to be linear also and approximately represented by the following formula, which holds over a range of wall thickness from 1.5 to 7.5 microns:

$$Y = 51.01X - 27.41$$

How the number of fibres having any given total cross-sectional area varies in a fairly uniform sample of American upland cotton is shown by Fig. 5 and Plate VI. This sample has an upper quartile length of 1.081 inches (1–3/32), mean length of 0.929 inch (15/16) and a coefficient of variation of length with weight of 26.3%; weight fineness of 3.82 micrograms per inch; average total cross-sectional area of 148.2 square microns; coefficient of variation of total area of 22.6%; lumen area of 13.1 square microns; Chandler bundle strength of 90,700 lbs. per square inch; and 36.0% thin-walled fibres.

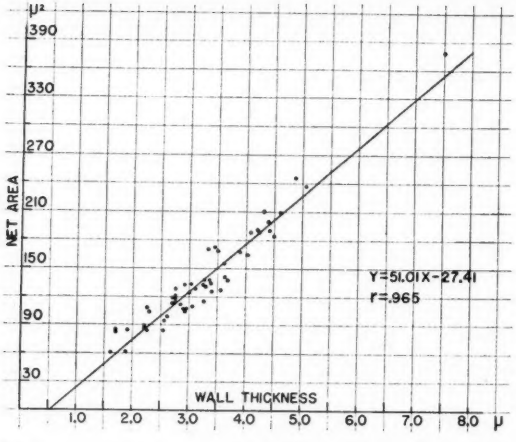

FIG. 4. Relation of average net area of fibre cross-section to wall thickness.

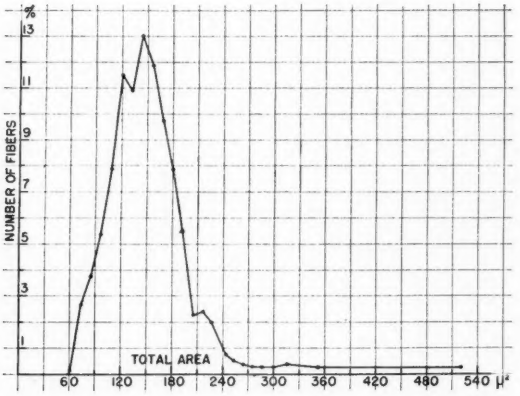

FIG. 5. Distribution of total area of cross-section in a fairly uniform sample of American upland cotton.

Cross-Sectional Characteristics of Certain Hopi and Acala Cottons and Their Progenies

To cotton breeders and physiologists, in particular, the cross-sectional features of the cotton fibre may offer some important bench-marks and valuable guidance in their breeding and selection activities, and in various

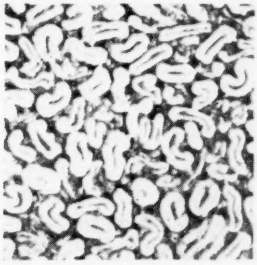

PLATE VI. Photomicrograph of cross-sections of fibres from a fairly uniform sample of American upland cotton. Approximately 350 ×.

types of experimental and analytical work. A few data of interest in this regard pertain to Hopi and Acala parents and their crosses shown in Plate VII and Table 6. A is a cross-section of the parent Hopi cotton; B, of the Parent Acala cotton; C, of the F_1 generation, and D and E of

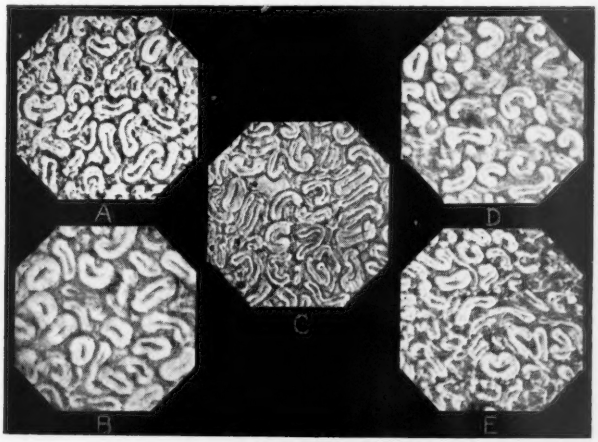

PLATE VII. Photomicrographs of cross-sections of cotton fibres from the Hopi and Acala parents and their progenies. (A) Hopi; (B) Acala; (C) the F_1 hybrid; (D) and (E) different samples from the F_2 generation. Approximately 375 ×.

the F_2 generation. The fibres of the F_1 are more ribbonlike; that is, the ratio of major to minor axis is larger than those of either parent. This characteristic is still more pronounced in the two samples of F_2, as shown in the table.

TABLE 6

Cross-sectional Characteristics of the Fibres of Hopi and Acala Cottons and of the First and Second Generation Progenies of Their Cross

Samples	Weight, μg./in.	Average areas μ^2					Average diameters, μ					Ave. wall thick. μ
		Total	Coef. of var.	Lumen	Net	Net / Total	Lumen Major	Lumen Minor	Fibre Major	Fibre Minor	Major / Minor	
A Hopi	3.9	147.6	23.38	18.9	128.7	2.83	12.1	1.50	19.8	7.00	2.83	2.75
B Acala	4.3	145.1	27.13	16.8	128.3	2.24	9.6	1.81	18.6	8.03	2.32	3.11
C F_1	3.5	105.4	35.8	18.9	86.5	3.47	13.6	1.07	19.1	5.50	3.47	2.22
D F_2	3.76	120.3	29.58	14.9	105.3	3.18	12.3	1.24	19.5	5.13	3.80	2.43
E F_2	2.97	122.8	34.7	19.68	105.2	3.21	12.3	1.32	19.2	5.98	3.21	2.33

The F_2 sample had smaller average total areas than the parent stock. The wall thickness of the crosses were definitely thinner than the parent samples; this fact is also indicated by the weight per inch determinations. Further study upon this particular problem is intended in cooperation with Dr. Kearney of the Bureau of Plant Industry.

Special Applications

With the development of a more rapid and practicable method for making cross-sections of fibres and of ways and means for more quickly and adequately comparing and evaluating cottons as to average geometrical fineness, the effects of various conditions of growth, such as heat, light, and nutrients, etc., on the cross-sectional features of fibres can be more effectively determined. Differences in varietal characteristics can be studied readily. It becomes of interest to examine cross-sections from base to tip of the fibre, and of fibres from different seeds, different portions of the same seed, from different plants, different locations on the plant, and different areas of growth.

As an example of application, the cross-sections of a series of Sea Island cottons, usually considered very uniform, were sectioned and measured. The results indicate that these cottons nevertheless vary greatly in cross-sectional size, shape, area of lumen, wall thickness and other fibre properties. For example, the average cross-sectional area in the nine Sea Island cottons varied from 95.2 to 123.4 square microns, the lumen areas from 9.2 to 15.0 square microns, the wall thickness from 2.23 to 3.27 microns and the weight per inch from 2.37 to 3.45 micrograms per inch.

A preliminary comparison of the cross-sectional features of two known varieties of cotton grown at the same place, cultivated and harvested in a definite manner during the two crop years 1936 and 1937, indicates that there are appreciable differences between the two crop years. Thus, while the average total areas of cross-section for the two years averaged respectively, 159.5 and 153.2 square microns, the lumen areas averaged 14.3 and 20.7 square microns; correspondingly, the net areas averaged 145.3 and 132.4 square microns and the wall thicknesses 3.16 and 2.85 microns, respectively. Other cross-sectional dimensions did not vary so greatly.

Further tests and studies are going forward as rapidly as possible. These findings possess especial interest because of the possible bearing that they will have on explaining, in part at least, differences in yarn strength and spinning quality which commercial manufacturers and the Bureau's laboratories have found with certain cottons and growths for the same two years.

Such a technic as has been described above should be of special value in explaining differences in spinning quality of experimental cottons grown, harvested, packaged, stored, and manufactured under different conditions. It also should be of special value in calibrating shipper and manufacturer types for use in the cotton trade. An extension of these applications looks forward toward a more general application in character standardization, at least in so far as the cross-sectional properties are concerned. The application can be carried easily to the cross-section of yarns to determine the types of fibres retained and the manner in which the fibres of different shapes are arranged and interlocked, in order to obtain information on the factors influencing yarn strength.

Summary.

The gradual increase in the use of more rigid and exacting specifications for special products manufactured from raw cotton, combined with the frequent inability of manufacturers and their representatives to recognize and secure raw cotton of the proper characteristics, has resulted in an awakening of interest on the part of many throughout the cotton enterprise in more rapid and practicable laboratory methods (even scientific ones) for the measurement of certain important cotton fibre properties. One of the more important of such fibre properties, fineness, cannot be evaluated with certainty at present by the usual methods of commercial classification. A more rapid and practicable method of evaluating fibre fineness of any sample, therefore, is urgently needed by many, more particularly cotton manufacturers and breeders.

A detailed description is given here of a modified and improved laboratory method for making and observing cross-sections of cotton fibres that is more rapid and practicable than any thus far described; also, of a scheme and graduated scales which have been developed for making comparisons and evaluations of fibre fineness on a basis of the cross-sectional area and shape.

Observations on a large number of cottons, selected to cover a wide range of growths and fibre fineness, have revealed a range of total fibre cross-sectional area of from 26 to 984 square microns, a net cross-sectional area from 22 to 944 square microns, and a wall thickness of from 0.35 to 15.5 microns.

The shapes of cross-sections of cotton fibres follow three principal types: namely, circular, elliptical and linear. On the basis of the ratio of major to minor axes, they may be sorted into three groups as: circular, with a diametral ratio of 1.00 to 1.80; elliptical, 1.81 to 4.00; and linear, 4.01 and higher.

The size of cross-sections of cotton fibres is determined on a basis of twelve panels with fibre cross-section photographs sorted and graduated into square microns, as follows: I, 0–79; II to XI in steps of 40 from 80 to 479; and XII, 480 and above.

Linear relationship exists with a high degree of correlation between weight per inch and total area of cross-section, between net area and total area, and between net area and wall thickness.

A high degree of variation in all cross-sectional features exists in every sample of cotton that has been tested. However, average values of these appear also to characterize different samples and varieties of cotton in a manner much as in the case of other physical properties customarily measured for cotton and other commodities.

The technic herein described should, when it is completely developed, provide a laboratory means for relatively easily and quickly observing the fibre cross-sectional characteristics of any sample and comparing them either with those of any other sample or with those of the comparison panels. Then and not until then can characteristic differences in the cross-sections of fibres from the same varieties but grown in different locations, or during different years, be readily and simply noted; and can valuable leads be developed by research people to explain certain differences in spinning behavior and yarn or fabric quality. More specifically, such technic should be useful to manufacturers who wish to study and check on their types or experimental lots of cotton; to the laboratory technologist doing research, who must examine relatively large numbers of samples; and above all, to the cotton breeder who needs better ways and means to guide him in making his selections and rejections.

As knowledge develops through the use of the technic described and as the tests can be made more rapid, this method of approach is expected to play an important part in laying a basis for the development of practical cotton character standards, in so far as fibre fineness is concerned. However, further work, more information and refined developments are needed along this line before any definite conclusions or steps can be taken in that direction.

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The Acetylation of Silk Fibroin by the Action of Acetic Anhydride

By EDWARD CARR *

A Textile Foundation Publication

Summary

1. *Quantitative data are presented on the acetylation of silk fibroin by the action of acetic anhydride under various conditions.*
2. *At room temperature pure acetic anhydride acts very slowly on silk fibroin. The free-amino groups of the protein are not completely acetylated in 48 hours, while the tyrosine hydroxyl groups are only slightly acetylated in 7 days. The acetyl (CH_3CO) content reaches 3.5% in 72 hours. The original white color of fibroin remains completely unchanged by long contact between the fibres and acetic anhydride at room temperature.*
3. *Between room temperature and 75° the rate of acetylation of silk fibroin by the action of pure acetic anhydride increases slowly with rise of temperature. Between 75° and the boiling point of acetic anhydride (137°) the rate of acetylation increases more rapidly with rise of temperature, being approximately proportional to the temperature.*
4. *The action of acetic anhydride on silk fibroin appears to consist of two independent and concurrent actions: (1) the simple acetylation of free active groups unaccompanied by appreciable degradation or color change of the fibres; (2) an action involving discoloration and weakening of the fibres without considerable acetylation, which action appears to be associated with the presence of acetic acid in the acetylating medium.*
5. *At 125° pure acetic anhydride acetylates silk fibroin to the extent of about 7.0% CH_3CO in 20–30 minutes with little change in the original white color of the fibres. Longer treatment at 125° results in slight additional acetylation, but increasing discoloration and weakening of the fibres.*
6. *Sodium acetate in the presence of acetic anhydride and acetic acid accelerates the acetylation of fibroin. Acetic acid does not accelerate the acetylation.*

Introduction

IN connection with recent work in this laboratory [1, 2] on the acetylation of silk fibroin by the action of gaseous ketene (CH_2CO) it was deemed desirable to expand the work to embrace the action of other acetylating agents. Such an extension serves to furnish a basis for a choice between

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alternative methods of acetylating fibroin, and to permit a comparative interpretation of the results obtained by the ketene method.

As discussed in a recent paper [2] the acetylation of silk fibroin by means of gaseous ketene is always accompanied by coloration of the fibres. The depth of the tan color varies from a light but definite shade to a pronounced tan depending on the duration of treatment. Since ketene characteristically undergoes slow spontaneous polymerization to a brown material [3] it is possible that the coloration of the fibres arises as the result of surface adsorption of the polymerization product. On the other hand, considerable amber color is removed from ketenized fibroin by solvents, leaving, however, a fast tan shade, which suggests that the color effect may be independent of the brown polymerization product, and perhaps may be associated with some unknown atomic grouping in the fibroin molecule.

A survey of the literature revealed little quantitative data on the action of the common acetylating agents on fibroin. Suida [4] attempted the acetylation of fibroin by means of acetic anhydride and acetyl chloride, but did not study the extent of acetylation or the blocking of active groups. He reported that these reagents appeared to be without effect on fibroin. Abderhalden [5] obtained quantitative data on the benzoylation of fibroin by means of benzoyl chloride in the presence of pyridine. His benzoylated product was of a reddish yellow color. Recently, New [6] has discussed acetylated fibroin in connection with electrical insulation, but does not mention conditions of the degree of acetylation. Other investigators have studied the action of a variety of acetylating agents on proteins under various conditions.[7] More recently Stern and White [8] extended the use of ketene by acetylating insulin in aqueous suspension.

The present paper deals with the acetylation of degummed silk fibres by the action of acetic anhydride under a variety of conditions.

Experimental

Materials. Raw Japanese White Silk * in the form of 4-gram skeins was degummed by treating it with 1% olive oil soap solution at 90°–100° C. for two hours. The skeins were then rinsed with lukewarm, distilled water until apparently free from soap and treated six times for 30 minutes with fresh portions of distilled water at 90°–100° C. Fibres so treated had no tendency to stick together when dry. The average loss of weight was 26%.

The acetic anhydride and sodium acetate used were of C. P. grade. Ninety-nine per cent acetic acid was once distilled.

Acetylation of Fibroin. Bundles of fibres up to 10 in. in length and weighing 1–2 grams were cut from degummed skeins and immersed in an acetylating bath contained in a flask. Since prior drying of the fibres proved to have no detectable effect on the rate of acetylation or on the color of the product most of the results recorded were obtained on samples initially at equilibrium with atmospheric moisture. The rate of acetylation was independent of the quantity of acetylating agent used so long as the latter was sufficient to cover the fibres.

Elevated temperatures were obtained by means of an oil bath. At the refluxing temperature of acetic anhydride a reflux condenser was fitted to the flask with a ground glass joint.

* Supplied by Cheney Brothers, silk manufacturers, South Manchester, Conn.

After the fibres had been in contact with a given acetylating bath for the desired period of time they were washed with water until free from the odor of acetic acid, were steeped in water at 50°–60° for 20 minutes and finally extracted with acetone. The acetone in the distilling flask of the extractor contained aqueous alkali to retain any acetic acid removed from the fibres. Repetition of the washing and extraction did not affect the acetyl content.

Acetyl analyses were carried out as previously described.[1, 2] Acetylating treatments lasting as long as 20 minutes yielded uniformly acetylated fibres, as indicated by the agreement of the results of acetyl analyses of a number of samples taken from a given acetylated product. The difference among such samples was not greater than 0.15% CH_3CO, which is only slightly greater than the precision of determining known quantities of acetic acid. In the case of shorter treatments the variation was as high as 0.25% CH_3CO.

The following acetylating baths were used: (1) acetic anhydride (Table I); (2) mixture of acetic anhydride and acetic acid 1: 1 by volume (Table II); (3) mixtures containing acetic anhydride and acetic acid in the proportion of 1: 1 by volume and sodium acetate in the proportions recorded in Table II.

At room temperature pure acetic anhydride acts very slowly on silk fibroin. In 48 hours the free *alpha* amino groups are not completely blocked, although the color test for these groups (ninhydrin) is considerably weakened. In 72 hours the ninhydrin color test is completely eliminated and the acetyl content reaches a value of 3.5%. The Millon test for free tyrosine hydroxyl groups is only slightly affected by seven days contact of the fibres with acetic anhydride at room temperature. The original white color of the fibres is unchanged under these conditions.

TABLE I

Treatment of Silk Fibroin with Ac_2O

Temp.	Time (hrs.)	% CH_3CO	Color of fibres
25°	24	1.1	white
	48	2.3	white
	72	3.5	white
75°	0.5	1.2	white (Curve I)
	1.0	1.8	white
	3.0	3.2	white
	6.0	4.2	white
100°	0.5	4.1	white (Curve II)
	1.0	5.3	white
	3.0	6.3	cream
137°	0.1	5.3	white (Curve III)
	0.25	6.9	white
	0.4	7.3	cream
	1.0	7.6	light tan
	3.0	7.9	tan
	7.0	8.6	dark brown

TABLE II

Treatment of Fibroin with Ac_2O, HOAc containing NaOAc at 100°; Ac_2O and HOAc in ratio of 1 : 1 by vol.

NaOc %	Time (hrs.)	% CH_3CO	Color of fibres
0	0.5	4.1	cream (Curve II)
	1.0	5.3	cream
	3.0	6.1	tan
4.5	0.5	5.9	white (Curve IV)
	1.0	6.5	white
	3.0	7.1	cream
	6.0	7.8	tan
10	0.1	5.3	white (Curve V)
	0.25	6.1	white
	0.50	6.5	white
	1.0	6.8	cream
	3.0	7.4	cream
	6.0	8.0	tan

At higher temperatures acetylation is more rapid. Between 75° and 125° the rate of acetylation increases fairly rapidly with rise of temperature (Table III). At the boiling point of acetic anhydride the acetylation of fibroin is practically completed in a few minutes (Curve III) with little discoloration or weakening of the fibres as judged by superficial examination. The steep portion of Curve III corresponds to complete blocking of the tyrosine hydroxyl and α-amino groups, and up to 7% CH_3CO corresponds

TABLE III

Effect of Temp. on Rate of Acetylation
30 minutes' Contact with Ac_2O

$t°$	% CH_3CO
25°	0
75°	1.2
100°	4.1
115°	5.9
125°	7.4
137°	7.5

to white fibres. Beyond 7% CH_3CO (Curve III) corresponds to increasing discoloration and loss of strength, with relatively little acetylation. Seven hours at 137° yields dark brown fibres which are practically devoid of tensile strength. Curve III might be interpreted as a composite curve consisting of one practically linear portion extending from the origin and a second linear portion intersecting the first in the neighborhood of 7.5% CH_3CO. On this interpretation the curve represents two independent actions of the acetylating medium which overlap at the turning point of the curve.

Curves I and II give the course of acetylation with pure acetic anhydride at 75° and 100° respectively. Curve II was obtained using either

pure acetic anhydride or a 1: 1 mixture of acetic anhydride and acetic acid. Using pure acetic anhydride at 100° (Curve II) the white color of the fibres remained unchanged during one hour's contact, while a 1:1 mixture of acetic anhydride and acetic acid at 100° (also Curve II) imparted a cream color to the fibres in 30 minutes.

Curve II gives the course of acetylation at 100° using a 1:1 mixture of acetic anhydride and acetic acid; Curves IV and V give the course when this mixture contains sodium acetate in the proportions of 4.5% and 10% respectively. Acetic acid was used in these mixtures in order to obtain an appreciable concentration of sodium acetate which is practically insoluble in the anhydride. It is apparent that sodium acetate catalyzes the acetylation reaction, while acetic acid does not.

The presence of acetic acid hastens the discoloration of the fibres. Acetic acid alone (Curve VI) or a 1:1 mixture of the anhydride and acid (Curve II) at 100° discolors the fibres (cream) in 30 minutes, while if the anhydride alone is used (also Curve II) the discoloration is delayed for an hour.

When sodium acetate is contained in the acetylating mixture the acetylation becomes well advanced (6.5% CH_3CO) before discoloration begins.

TABLE IV

Acetylation of Fibroin by Acetic Anhydride Vapor
Temperature 137° C.

Minutes	% CH_3CO	Color
10	5.6	White
20	6.9	Cream
30	7.4	Cream

It is apparent that the discoloration of the fibres is not determined solely by the degree of acetylation, nor by the mere blocking of amino or tyrosine hydroxyl groups. Since the discoloration is more readily obtained in higher concentrations of acetic acid and at higher temperatures, and since Curve III has an abrupt turning point, it is to be inferred that the discoloration is independent of the mere acetylating action of acetic anhydride.

As in the case of ketenized fibroin [1, 2] the acetylated fibres obtained by the action of acetic anhydride give a negative Millon reaction for acetyl values of about 7%, and a negative ninhydrin reaction for acetyl values of about 3%.

The acetyl content of the fibres is not changed by 5-minutes boiling with water. Longer boiling slowly decreases the acetyl content and favors the Millon test. The esterified tyrosine hydroxyl groups are quite sensitive to dilute alkali, while the acetylated amino groups are relatively indifferent.

Acetylation of Fibroin by Acetic Anhydride Vapor. A glass apparatus was devised which permitted of continuously circulating acetic anhydride vapor over a quantity of degummed silk fibres. The chamber containing the fibres was maintained at the boiling temperature of acetic anhydride in order to prevent condensation upon the fibres. The vapor was condensed externally to the exposure chamber and returned to an ebullition flask. The method is equally as effective as treating the fibres with liquid acetic an-

hydride, and in addition possesses the advantage that the fibres remain dry and almost free from excess of acetic anhydride. The odor of free acetic anhydride is completely removed by a current of air acting on the treated fibres at room temperature.

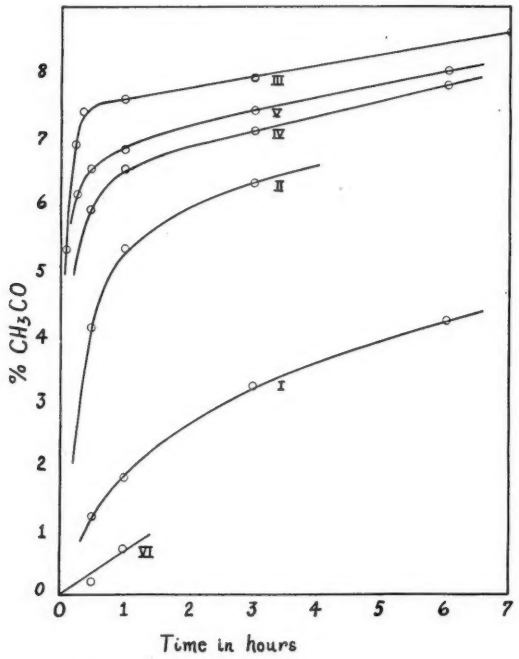

FIG. 1. Acetylation of silk fibroin with acetic anhydride under various conditions.

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"*ORGANIZED RESEARCH has become the dominant competitive weapon for the individual establishment. And more than research, the development of a new idea from its genesis until the time when it meets the acclaim from the consumer is a fresh art, the knowledge of which is enabling many companies to establish entirely new competitive frontiers. It is safe to say that within the next decade the company which cannot introduce into its processing the new product, the new design, the new formula with as great facility as it introduces raw material into its process will be definitely obsolete from the point of competitive armament. The measure of this need in any particular establishment is simple. The rate at which older markets wane establishes the rate at which newer markets must be developed.*"—**Prof. Erwin H. Schell,** *American Gas Journal,* **March, 1938.**

Abstracts

Committee on Abstracts and Bibliography:
E. R. Schwarz, Chm., M. W. Weiss, Dr. E. J. Saxl, C. H. Clark.

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Address, C. H. Clark, Sec., 65 Franklin St., Boston, Mass.

I. Fibres (Synthetic and Natural) and Fibre Analysis

Staple Fibre Phrix BM: New Very Curly. R. Jaeger. *Mell. Textilber. (German ed.)*, 1938, No. 6, P. 486.

The author gives a number of samples showing the appearance of cloth made with the new type of staple fibre Phrix BK with permanent curl. The metrical count is 3220, the denier 2.8, the dry breaking length 20.1 km. and 12.8 km. in the wet state, the dry breaking load of 6.23 g. and 3.96 in the wet state, the relative tensile strength when wet 3.27%, the breaking elongation 15.7% when dry and 20.6% when wet. Goods made with Phrix BK have a woolly handle owing to the permanent curl of the fibre. (C)

Sulphur Content of Intercellular Phase of Wool Fibre. J. B. Speakman and P. R. McMahon. *Nature*, 1938, V. 141, P. 118–9; abs. in *J. Soc. Dyers Col.*, March 1938, P. 133.

Cells isolated from the root-ends of non-medullated merino wool staples by the action of trypsin had a sulphur content $>$ that of the original wool. It is inferred that the amorphous intercellular phase of the fibre has a sulphur content $<$ that of the cells. (C)

"Swarza" Staple Fibre: Production and Properties. H. Jentgen. *Kunstseide*, 1938, V. 20, P. 83–5; abs. in *J. T. I.*, June 1938, P. A324.

The production of Schwarza staple fibre is described and contrasted with the usual viscose staple fibre process. Preparation, ageing and shred-

ding of the alkali cellulose are carried out by a continuous process and preparation and solution of viscose are carried out in one operation in a "Vacuum-Xanthate" apparatus. The viscose is spun by the stretch-spinning method and washing, desulphurizing and other after-treatments are applied to the rope of continuous filaments hanging in loops round the edges of rotating discs which are sprayed with the required liquids. The filaments are then cut and dried by the usual methods. Schwarza W1 has a fineness of 3.75 denier, a wool-like handle and matt appearance. It has a stable curl, dyes easily and has a low alkali-solubility. Schwarza staple fibre T8 has a fineness of 8 denier and is suitable for the preparation of yarns of medium count. Merinowa, an animalized staple fibre of 3.75 denier, which is very similar to merino wool and has a stable curl, will shortly be placed on the market. Telusa T16 and Tulusou T24 are particularly suitable for use in the carpet, plush and moquette industries and for mixing with alpaca and mohair. In general, Schwarza staple fibre has a wet strength equal to that of the best wool qualities and a higher dry strength than wool. It also has a stable curl, good adhering and thermal insulating powers, and is suitable for mixing with wool. (C)

TEXTILE FIBRES: MOISTURE RELATIONS. W. G. Schaposchnikov. *Sbirnik Inst. Akad. Nauk, U.S.S.R.*, 1937, No. 3, P. 119–40 (through *Chem. Zentr.*, 1938, i, P. 471); abs. in *J. T. I.*, May 1938, P. A298.

Observations on the moisture absorption and desorption of vegetable, animal and artificial fibres, extending over several months, are said not to give any evidence of hysteresis. (C)

TEXTILE FIBRES: SUB-MICROSCOPIC STRUCTURE. A. Frey-Wyssling. *Protoplasma*, 1937, V. 27, P. 372–411 (through *Bot. Zbl.*, 1938, V. 172, P. 163); abs. in *J. T. I.*, March 1938, P. A166.

An X-ray investigation of the intermicellary spaces in fibres has been carried out by staining them with the dichroic gold and silver stains and measuring the size of the metallic particles. The X-ray measurements point to a mean particle size of 85–135 A in cellulose, 50 A in viscose rayon and real silk, and 60 A in cellulose acetate rayon and wool. The result is unexpected since calculations of intermicellary space from swelling measurements lead to diameters of a lower order of magnitude. Considerations of the dichroism suggest, however, that the sub-microscopic system is one of very long capillaries (possibly continuous ones) with diameter about 100 A. A distinction is drawn, therefore, between intermicellary spaces accessible to swelling agents and these new sub-microscopic capillaries that are filled with protoplasm or incrusting substances in the living fibre and with air in the dried condition. (C)

VISCOSE FILAMENTS: DEFORMATION AND STRUCTURE. (1) P. H. Hermans. (2) P. H. Hermans and A. J. de Leeuw. *Kolloid-Z.*, 1937, V. 81, P. 143–50, 300–26; abs. in *J. T. I.*, March 1938, P. A166.

VISCOSE FILAMENTS: DEFORMATION AND STRUCTURE. P. H. Hermans and A. J. de Leeuw. *Kolloid-Z.*, 1938, V. 82, P. 59–67; abs. in *J. T. I.*, April 1938, P. A229.

Experiments previously described on the swelling anisotropy of strongly swollen cellulose hydrate gels (viscose filaments) have been extended to

gels of a lower degree of swelling The stretching of swollen isotropic filaments results in an almost complete orientation of the particles in the direction of the extension but there is scarcely any orientation with air-dry filaments although both show an almost equal extensibility. In the dry state the inner structure is torn and numerous gas-filled hollow spaces of ultra-microscopic dimensions occur in the filament, which produce a matt, white turbidity of the gel. By displacing the water of strongly swollen cellulose by organic solvents voluminous organo-gels can be produced, which contain only about 50% of cellulose by volume. On evaporation dull white cellulose aerogels are formed with a specific gravity less than unity. These gels retain very strongly considerable quantities of organic liquids. Judged by swelling anisotropy, a more complete arrangement of the elementary particles takes place by extension of these aero- and organo-gels than by the extension of compact dry cellulose filaments, but the orientation is less complete than with strongly swollen hydro-gels. It is shown that for a given degree of stretch the titer of the stretched filament in the dry state is dependent on the degree of swelling during the stretching process, decreasing on increasing the degree of swelling. (C)

WOOL: ACTION OF CYANAMIDE ON. J. B. Speakman, B. Nilssen and C. S. Whewell. *Nature*, 1938, V. 141, P. 688–9; abs. in *J. T. I.*, June 1938, P. A321.

A curve is given showing the changes in the resistance to extension of wool fibres in buffer solutions of varying pH, with and without previous cyanamide treatment to convert cysteine side chains into derivatives of isothiourea. The results support the salt linkage hypothesis of the structure of wool. The enhanced reducing power of exposed wool is minimized by cyanamide treatment. (C)

WOOL AND HAIR: PRODUCTION AND STRUCTURE OF. H. R. Marston. *Australian Chem. Inst. J. and Proc.*, 1937, V. 4, P. 393–400 (through *C. A.*, 1938, V. 32, Col. 2756); abs. in *J. T. I.*, June 1938, P. A321.

Stratum granulosum cells may orient and bind through –SH groups a long chain molecule spring forming wool fibre. Limited wool production on low protein diet is increased by cystine feeding; no other sulphur compound had any effect. Possible increase after subcutaneous methionine may be due to cystine sparing. (C)

WOOL: BIBLIOGRAPHY ON CHEMISTRY OF. Arthur L. Smith and Milton Harris. *Am. Dye. Rptr.*, 1938, April 4, P. 183–98; July 11, P. 363–92.

"This bibliography is limited to publications dealing principally with the more fundamental aspects of the chemistry of wool. Publications relating to industrial processes and to physical testing have been included only if they bear upon the interpretation of chemical properties. Although it has been necessary to exercise personal judgment in the selection of papers to be included, no paper has been excluded because of the doubtful validity of the data or theories given in it. The chief sources of material were *Chemical Abstracts, British Chemical Abstracts,* and *Chemisches Zentralblatt,* and wherever possible, abstracts were taken directly from these journals. The bibliography has been compiled as part of a program of research on the chemistry of wool which is being done at the National Bu-

reau of Standards for the American Association of Textile Chemists and Colorists under the Research Associate plan." (C)

WOOL FAT: CHEMISTRY AND TECHNOLOGY OF. L. Wilson Greene. *Tex. Col.*, March 1938, P. 153–6.

The chemical composition, recovery and uses of wool fat are discussed, and accompanied by numerous literature references. (C)

WOOL: REACTION OF WITH HYDROGEN PEROXIDE. H. A. Rutherford and Milton Harris. *B. S. J. Rsch.*, April 1938, P. 559–61; *Am. Dye. Rptr.*, April 4, 1938, P. 173–4.

The reaction of wool with hydrogen peroxide was investigated. The basic groups in wool are unaffected during treatment with hydrogen peroxide, as indicated by the determination of the amino nitrogen, arginine, and lysine contents. The percentage of each of the elements in wool with the exception of oxygen decreases with increased oxidation but the ratios of these elements remain constant. The results constitute further evidence that the main reaction of wool with hydrogen peroxide is the addition of oxygen to the disulfide groups. (C)

WOOL: RECENT THEORIES ON THE FELTING OF. Herman Boxser. *Am. Dye. Rptr.*, June 13, 1938, P. 311–6.

A review of the more recent explanations of the felting phenomenon of wool and fur fibres. The author feels that continued research on the chemical structure of wool will result in the practical production of simple processes which will enhance the shrinkage of wool on one hand, and other processes which will render wool shrinkproof. (C)

II. YARNS AND FABRICS

AIRPLANE DOPES: SUITABILITY OF VARIOUS PLASTICS FOR USE IN. Gordon M. Kline and Cyrus G. Malmberg. *B. S. J. Rsch.*, May 1938, P. 651–71.

A number of different cellulose derivatives of potential interest as film-forming constituents for airplane dopes have recently become available commercially. An investigation has been undertaken at the National Bureau of Standards to determine the fundamental factors involved in the formulation of dopes containing these new derivatives to obtain optimum tautness and durability. Data are presented in this paper relative to the effect of varying the acyl or ethoxyl content and the viscosity of cellulose esters and ethers on the tautness of fabrics doped with them. It is concluded that the solvents and diluents govern to a large extent the tautening properties of the dope and the durability of the film deposited on the fabric. (C)

ALGINATE SIZING AND FINISHING COMPOSITIONS: APPLICATION. P. Colomb. *Teintex*, 1938, V. 3, P. 94–101; abs. in *J. T. I.*, June 1938, P. A348.

A general account is given of the preparation of alginates and their use in various types of finishes, including weighting and waterproofing finishes, for different types of cotton, woolen, rayon and mixture fabrics, in the sizing of rayon, in the treatment of leather and in mural decoration. Numerous recipes are given. (C)

ANTIDOTE FOR HIGHER COSTS. Albert Palmer. *Tex. Wld.*, Mar. 1938, P. 62–3.

Increased output per machine and per operative an offset to possible wage and hour restrictions. (C)

BREAKING TWIST AND TWIST STRENGTH. W. Frenzel and W. Harzer. *Mell. Textilber. (German ed.)*, 1938, No. 7, P. 555.

The authors refer to the connections between breaking twist and the degree of breaking twist, and between twist strength and twist circular length. Investigations were carried out on cotton roving and cotton yarn of uniform length between clips and accompanied by slipping of the fibres. The resistance that the yarn offers to twisting rises with the degree of twist. It was found that the tension in the yarn is higher for the same twist, the lower the yarn count. The yarn tension for a given twist falls off hyperbolically as the yarn count increases. In order to produce a definite tension in a yarn, the number of twists must be raised the finer the yarn is. The course of the tension has been accurately determined in this case and has been found to be parabolic. (C)

COTTON SPINNING TESTS AND RELATED FIBRE STUDIES. Malcolm E. Campbell. *Textile Bulletin*, June 30, 1938.

Address, Annual Convention of Southern Textile Assoc., Blowing Rock, N. C., June 17, 1938. (C)

COTTON SPINNING WITH DIFFERENT SCHEMES OF DRAFTS. Nazir Ahmad. Technological Bulletin No. A41, Indian Central Cotton Committee, Bombay; *Tex. Mfr.*, May 1938, P. 181–2.

Variation of drafts from an accepted scheme showed weaker yarn with the extreme changes, but some possibilities of economy. (C)

COTTON WAX: REMOVAL IN SCOURING; COMPARISON OF PROCESSES. L. Kollman. *Mell. Textilber.*, 1937, V. 18, P. 994–7; abs. in *J. T. I.*, March 1938, P. A148. (C)

CRABBING AND STEAMING: USE OF BORAX. G. L. Atkinson. *Text. Mercury*, 1938, V. 98, P. 289–90; abs. in *J. T. I.*, June 1938, P. A349.

A 2% solution of borax added to the liquor in the crabbing bowl has a buffering effect; the process of transition to the plastic state is shortened, with decrease of structural damage, especially in the case of those fabrics deficient in sulphur content. If the temperature of subsequent processes, *e.g.*, dyeing, approaches or equals that of crabbing, the permanency of the set is impaired. The use of borax tends to prevent the deposition of oils, etc., on the fabric, and thus diminishes the number of dyeing faults. (C)

DESIGN OF NEW WEAVES. J. Kunz. *Mell. Textilber. (German ed.)*, 1938, No. 7, P. 561.

The author shows how new weaves can be created simply by twisting the ground weave by 90 degrees. By using a sub-grouping in addition, the possibilities of creating new weaves are practically inexhaustible. (C)

EQUALIZATION BY DOUBLING. Franz Tobisch. *Mell. Textilber.* (*German ed.*), 1938, No. 7, P. 549.

The author has carried out numerous theoretical calculations in order to find out the effect of doubling upon the uniformity of the final product. He is able to show that the range of deviation of card slivers cannot be enlarged by doubling, so that they can only become more uniform. The equalizing effect of doubling depends only on the total number of doublings, and the way in which the total doubling has been made up has no effect upon equalization. (C)

FABRIC DEFECTS: THEIR CAUSES AND POSSIBLE PREVENTION. Charles J. Huber. *Am. Dye. Rptr.*, April 18, 1938, P. 217–20.

Paper presented at meeting, New York Section A. A. T. C. C., Jan. 28, 1938. (C)

FLAX PRODUCTION AND PROCESSING. S. A. G. Caldwell. *Tex. Mfr.*, May 1938, P. 185–6.

A review of some of the latest achievements, including pedigreed seed, mechanized pulling, warm-water and enzyme retting, automatic scutching, etc. (C)

HEAT-RESISTING (COTTON) CORD. Anon. *Tex. Wld.*, Mar. 1938, P. 60–1.

Chemical and other methods for producing cords with low stretch and high tensile strength for use in tires and mechanical goods. (C)

HOSIERY DEFECTS AND THEIR CORRECTION: CAUSES OF SOME COMMON. H. H. Mosher. *Am. Dye. Rptr.*, April 18, 1938, P. 206–12. (C)

KNITTED WOOL FABRICS: WATERPROOFING. S. R. Trotman. *Chem. & Ind.*, 1938, V. 57, P. 56–60; abs. in *J. T. I.*, May 1938, P. A287. (C)

LARGE-PACKAGE THROWING. Henry Miedendorp, Jr. *Tex. Wld.*, May 1938, P. 69.

Its advantages, especially for single-end rayon crêpe. (C)

MECHANICAL PROGRESS IN WEAVING. Albert Palmer. *Rayon Tex. Mo.*, 1938, March, P. 71–2; April, P. 76–8.

Abstract of paper presented at a meeting of the Textile Society of Canada, Eastern Div. The author shows how the fabric manufacturer can reduce his costs by increased output per loom and per operative, and thus combat the wage and hour laws of this country. (C)

METALLIC OR ORDINARY (COTTON) CARD CLOTHING? H. Holt. *Tex. Mfr.*, May 1938, P. 187, 212.

The author's conclusions on the use of metallic clothing compared with ordinary clothing are as follows: "More production can be obtained; less waste; less labor for stripping and grinding; more labor for setting and supervision and more care; a sliver of lower quality; a dirtier card-room; more prone to accident; requires fresh methods of stripping and grinding; unsuitable for carded yarns; most suitable for rayon staple fibre, and can

be safely used for combed yarns. As there are scarcely two mills alike each individual firm must decide which clothing suits best its type of production."

New Finishes—New Problems. Winn W. Chase. *Tex. Wld.*, Mar. 1938, P. 67.

The author refers to the claims of a "well-known authority on dry cleaning" to the effect that garments, believed to have been sized or finished with synthetic resins, tend to develop a disagreeable odor after dry cleaning, that white garments thus finished and dry cleaned are badly grayed, and that in some cases have caused poisoning where parts of the garment have come in contact with the damp, warm body of the wearer. It is suggested that there should be a scientific investigation to determine the behavior during consumer use of fabrics thus treated. (C)

Oiled Silk. Philip LeBrun. *Tex. Wld.*, Mar. 1938, P. 56.

Describes use of resin lacquers for this purpose. (C)

Oiling Problems in the Worsted Industry. J. Barritt. *J. T. I.*, March 1938, P. P47–P59.

A lecture covering results of a comparative study of olive and alternative worsted oils conducted by the British Wool Industries Research Association. The lecturer closed with the following significant statement, after noting that the work is to be extended to tops of various qualities: "It may throw further light on the suggestion already put forward that for optimum spinning results, different wools may require oils with different characteristics, and that one reason at least for the widespread use of olive oil is that it occupies an average position with respect to viscosity." (C)

III. Chemical and Other Processing (Not Otherwise Classified)

Alizarin Red: Mechanism of Dyeing Process. R. Haller. *Helv. Chim. Acta*, 1938, V. 21, P. 302–8; abs. in *J. T. I.*, June 1938, P. A345. (C)

Bleaching Liquor: Electrolytic Preparation. M. Maillard. *Rev. gén. mat. col.*, 1938, V. 42, P. 104–5; abs. in *J. T. I.*, May 1938, P. A282.

In an improved method for the preparation of bleaching liquor by the electrolysis of sodium chloride solution, the liquid is kept in circulation by the hydrogen produced in course of the electrolysis. The cell is provided at the top with two vertical tubes which are connected in their upper parts. Liquid carried up one by the hydrogen falls back down the other. A maximum yield is obtained in this way and escape of chlorine is prevented. The apparatus can be installed in the bleach works close to the vessels in which the hypochlorite liquor is to be used. Costs of production are estimated and shown to be very much lower than the usual purchase price of bleaching liquors. (C)

"Brandom" Dyed Yarns: Production. J. Brandwood. *Silk J. Rayon Wld.*, 1937, V. 14, No. 163, P. 34–5; abs. in *J. T. I.*, March 1938, P. A150.

The Brandwood process for dyeing yarn so as to obtain a more or less random distribution of color is briefly described and samples of poplin, crash and furnishing fabrics are provided to illustrate effects obtainable with such "patterned" yarns. More than 2,000 designs of "Brandom" yarns are now available. (C)

Colloidal Aspect of Textile Chemistry. G. S. Ranshaw. *Dyer*, 1937, V, 78, P. 71–2, 121–3, 169–71, 217–8, 271–2, 323–4, 373–4, 427–8, 481–2, 531–2, 579–80; 1938, V. 79, P. 15–6; abs. in *J. T. I.*, April 1938, P. A252.

A series of articles dealing with the colloidal aspects of bleaching, dyeing and wet finishing, under the following headings: dispersions; suspensions and emulsions; capillary activity; wetting; soaps as colloids; textile soaps; sulphonated oils and fatty alcohols; alkyl naphthalene derivatives and fatty condensation products; fixation of dyestuffs, delustring and stripping. (C)

Cotton and Rayon: Treatment to Impart Affinity for Acid Dyes. A. J. Hall. *Silk & Rayon*, 1938, V. 12, P. 168, 170, 196; abs in *J. T. I.*, April 1938, P. A218.

Cotton and viscose rayon may be converted into forms having affinity for acid dyes by treatment with an aromatic sulphochloride in the presence of a tertiary or secondary amine or by treatment with aldehydes or ketones and pyridine bases or the salts of such bases with strong acids. The author discusses the modification of the cellulose produced by these methods and the properties of the treated materials. (C)

Cotton-Cellulose Acetate Rayon Mixtures: Dyeing. J. Rolland. *Teintex*, 1937, V. 2, P. 741–4; abs. in *J. T. I.*, June 1938, P. A344. (C)

Cotton Proteins: Influence in Bleaching Processes. E. Kornreich. *Mell. Textilber.*, 1938, V. 19, P. 61–3; abs. in *J. T. I.*, April 1938, P. A215.

On treatment of cotton with alkali under pressure, the proteins in the cotton pass into colloidal solution in the alkali and increase the emulsifying power of the latter. Complete removal of the proteins in this process is, however, hindered by the absorptive power of cellulose for colloidal substances. In chlorine bleaching processes, cotton proteins are converted to chloramines which have bleaching and oxidizing powers. Alkali dissolves them and concentrated alkali converts them to forms not giving active chlorine reactions. In acid solutions the chloramines are precipitated and fixed on the fibre, and in this state are difficult to decompose and also retain a certain amount of absorbed acid. In alkaline hydrogen peroxide solutions, cotton proteins are dissolved and bleached and they exert a stabilizing action on the peroxide solution. In the scour-chlorine bleach combination most of the proteins are removed in the scouring process and chloramines are only formed to a small extent in the chlorine bleaching operation. In the chlorine-peroxide bleaching process, the chloramines

formed in the chlorine treatment are dissolved by the alkaline hydrogen peroxide and react with the latter at high temperatures. The chloramines also have a stabilizing action on hydrogen peroxide solutions. Cotton proteins are almost completely removed by a scour-chlorine-peroxide bleaching treatment and this is the best method of purification. (C)

DEGREASING DYE LIQUORS: APPLICATION. C. Schöller. *Mell. Textilber.*, 1938, V. 19, P. 57–61; abs. in *J. T. I.*, April 1938, P. A217.

Oils and fats may be removed from textile materials in the dyeing process by using a dye bath containing an assistant having both leveling and degreasing properties. The efficiencies of Igepon T and Leonil O for this purpose have been tested in a series of experiments on wool in the form of fabrics, yarns, loose fibre and waste, impregnated with various oils. The experiments are described in detail and the results are discussed. (C)

DYE PARTICLES: CRYSTAL STRUCTURE AND FASTNESS TO RUBBING. E. Valko. *Techn. Kurir*, 1937, V. 8, P. 93–6 (through *Chem. Zentr.*, 1938, i, P. 1663); abs. in *J. T. I.*, June 1938, P. A344. (C)

DYEING RAWSTOCK UNIFORMLY: FUNDAMENTALS OF. L. E. Whittelsey. *Am. Dye. Rptr.*, June 27, 1938, P. 346–9.

Presented at meeting, Southeastern Section, A. A. T. C. C., April 23, 1938. (C)

FASTNESS REQUIREMENTS OF PRINTED COTTONS. E. M. Edgerton. *Am. Dye. Rptr.*, June 13, 1938, P. 320–4.

Presented at meeting, Piedmont Section, A. A. T. C. C., Feb. 19, 1938. The author recommended that the A. A. T. C. C. committee on wash fastness consider the development of a suitable standard wash test for "Guaranteed Fast Colors," and reconsider its present A. A. T. C. C. Test No. 2 from the standpoint of increasing its severity by lengthening the time of washing (and including some Fade-Ometer requirements) so that this test could be accepted as a standard for "Fast to Washing Colors." Such tests would be sufficiently comprehensive to replace the present great variety of independent wash tests by reason of their being severe enough to cover the requirements of any of the reasonable independent tests and to insure a better degree of protection against home laundering. (C)

FLUORESCENT DYES: APPLICATION. G. Martin. *Rev. gén. mat. col.*, 1938, V. 42, P. 81–4; abs. in *J. T. I.*, May 1938, P. A284.

A general discussion of the phenomena of fluorescence, sources of ultraviolet light, the application of fluorescence effects in dyeworks laboratories for the identification of dyes and for the detection of faults in printing, and the use of fluorescent materials for the production of artistic effects such as those obtained by the use of fluorescent paints and varnishes and of fabrics dyed and printed with fluorescent dyes, especially for theatrical purposes. (C)

GERMAN TEXTILE ASSISTANTS: APPLICATION. C. H. Fischer. *Kunstseide*, 1938, V. 20, P. 123–7; abs. in *J. T. I.*, June 1937, P. A341.

Notes are given on the nature and application of various German oiling, sizing, desizing, washing and scouring preparations, wetting agents and

other textile assistants for use in the treatment of rayon and staple fibre products. (C)

GLYCERIDES, FATTY ACIDS AND MINERAL OILS: USE IN PRODUCTION OF PLASTIC PRODUCTS. L. Bonnet. *Teintex*, 1937, V. 2, P. 755–9; abs. in *J. T. I.*, June 1938, P. A347.

Patent literature relating to the use of glycerides, fats, fatty acids and mineral oils in the manufacture of plastic products is reviewed and the possibility of using such products for the production of permanent finishes on textile materials is mentioned. (C)

IV. RESEARCH METHODS AND APPARATUS

EMBEDDING FIBRES FOR SECTION CUTTING IN A MEDIUM CONTAINING ETHYL CELLULOSE: METHOD OF. C. M. Barlow. *J. T. I.*, May 1938, P. T111–T116. (C)

FIBRE STRESS-EXTENSION RECORDING DYNAMOMETER. D. Demeulemeester and I. Nicoloff. *L'Ingénieur Text.*, 1937, No. 339, P. 444–62; abs. in *J. T. I.*, March 1938, P. A167.

A detailed description is given of a recording dynamometer which has been described briefly in a previous paper. Causes of irregularities, amplification by means of a thyratron, the characteristics of the apparatus and its sensitivity are discussed and typical results are shown. (C)

FIBRES: CLINGING POWER AND FRICTION. O. Schmidhauser and R. Stoll. *Klepzig's Textil-Z.*, 1938, V. 41, P. 103–14; abs. in *J. T. I.*, May 1938, P. A298.

The influence of structure, especially surface structure, fineness, flexibility and other characteristics of textile fibres on their clinging power is discussed. The influence of clinging power in textile processes is pointed out and various attempts to measure it are critically reviewed. A method based on measurements of the frictional resistance on drawing out a bundle of fibres, starting from a state of rest, is described. The tuft of fibres is pressed between clamp jaws which are provided with a fixed lining of fibres of the type being tested. The jaws are pressed togethr, by means of a suitable lever system, with a pressure which can be varied as required. A load is applied to the fibre tuft and is increased until the tuft is drawn out. The load at this moment is a measure of the frictional resistance between the fibre tuft and the fibre linings of the clamp jaws. The results of tests on wool, cotton and staple fibres with various pressures between the jaws are shown in the form of frictional resistance-pressure curves. As the pressure increases the curves change into straight lines, which, if extended, do not in general pass through the origin but cut the frictional resistance axis. This effect is attributed to the influence of fibre structure, curl, etc., and is most apparent in the case of wool and smallest in the case of staple fibres. Expressions are deduced for the coefficient of friction, the coefficient of friction for fibre of 1-denier fineness, and a corrected coefficient of friction which is comparable with the coefficient of friction as defined in mechanics. The values for the different fibres are compared. The effects of humidity, mercerization, dyeing, etc.,

on fibre-on-fibre frictional resistance, handle and flexibility and on behavior in processing are briefly discussed. (C)

FIBRES: STRUCTURE. W. Shramek and J. Helm. *Leip. Monats. Text. Ind.*, 1937, V. 52, P. 317–29; abs. in *J. T. I.*, March 1938, P. A166.

A review of microscopic methods for the study of the structure of fibres, including methods for the study of the fibre surface, methods for the study of the fibre interior by means of observations of longtitudinal and cross-sections, and methods depending on plastic reconstruction of fibres from their cross-sections. Photomicrographs of various wool fibres and animal hairs are given. (C)

FIBRES: SURFACE STRUCTURE; MICROSCOPIC INVESTIGATION. A. Herzog. *Mell. Textilber.*, 1938, V. 19, P. 13–6; abs. in *J. T. I.*, April 1938, P. A288.

The advantages of the half-embedding procedure for the microscopic study of the surface structure of fibres described by Manby and Hardy and later improved by Reumuth are pointed out and various disadvantages and deficiencies of this method are discussed. A method for the study of the surface structure of wool and hairs which depends on the preparation of an impression of the surface in resin or similar material is mentioned and the use of the stereoscopic microscope is briefly discussed. Photomicrographs of wool, various animal hairs and cotton hairs are reproduced and discussed. (C)

FLEXIBILITY OF TEXTILES: MEASURING THE. PART I. Werzmirzowsky. *Mell. Textilber.* (*German ed.*), 1938, No. 6, P. 483.

The author defines the terms flexibility, creasibility, and the expression "bedding value" to indicate the flexibility of textiles. The Schopper bending tester is used for measuring flexibility. The range of variation shown by individual bending tests is comparatively large. The shape of the clip used for bending and the direction in which the sample is inserted in the clips have a considerable influence upon the results. The bending number is to a great extent independent of the pressure exerted in clamping in the sample, the speed of bending, and the length of the sample between the clips. No linear relations exist between width of the sample, the preliminary tension, and the bending number. The way in which the bending number depends on the preliminary tension can be represented as a hyperbolic equation.

PART II. *Ibid.*, 1938, No. 7, P. 575. In the present continuation of his article the author deals with the problems arising out of the structure of the fabrics in regard to pliability and bending value, both of which factors show extraordinary variation for the various textile raw materials. These values are lowest for rayon and staple fibre, rather higher for bast fibres, and by far the highest for wool and cotton. They are both functions of the yarn count and twist. (C)